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Up in the Air: A Global Estimate of Non-Violent Drone Use 2009-2015

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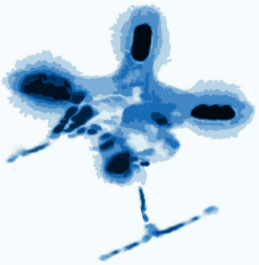

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The Joan B. Kroc School of Peace Studies (University of San Diego) is a graduate school focused on promoting peacebuilding and social justice. The School integrates teaching, research, and practice inside the classroom as well as in project-based efforts like this report. Hands-on work at the local, regional, binational, and international level is directly supported by faculty and is facilitated by the Institute for Peace and Justice, the Trans-Border Institute, and the Center for Peace and Commerce.

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About the Good Drone Lab **www.thegooddronelab.com**
The Good Drone Lab focuses specifically on the benefits new technology bring to social movements and other non-profit actors working for the greater good. The Lab is currently focused on three primary areas: scholarly research, technological innovation, and general support for advocacy efforts.

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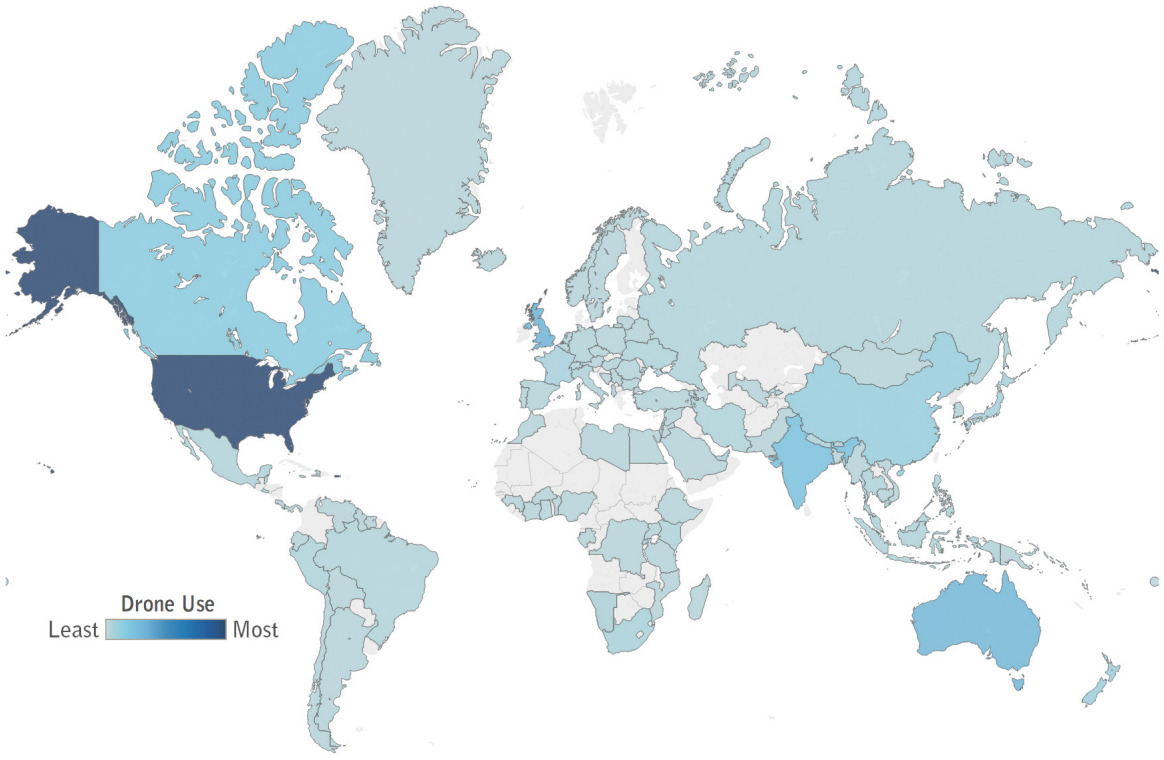
1 Introduction

1.1 - Key Findings

- We report on 1,145 discrete cases of drone use, drawn from careful analysis of 15,000 news reports covering six years (2009-2015) of all uses except weaponized military use.
- Drones are being used in more than half of the world's countries (108) and by a growing number of international actors and everyday individuals.
- The year 2012 was a breakout period that saw non-military use overtake military use.
- The United States sees more reported drone use every year than any other country.
- Government users represent the single largest category of users.
- Scientific Research represents the single largest category of use.
- Commercial, emergency services, health and public safety, and environmental conservation sectors are growing.
- Legislation is sparse and uneven, but growing.
- Twenty-eight U.S. states have passed forty-one UAV-related laws.
- Several dozen countries have some form of legislation covering drones, with the majority passed recently.
- Most regulations focuses on controlling weight, altitude, distance, no-fly zones, and operator certification.
- There is no consensus policy on non-military drone use.

Figure 1.1 - National prevalence of drone use: 2009-2015

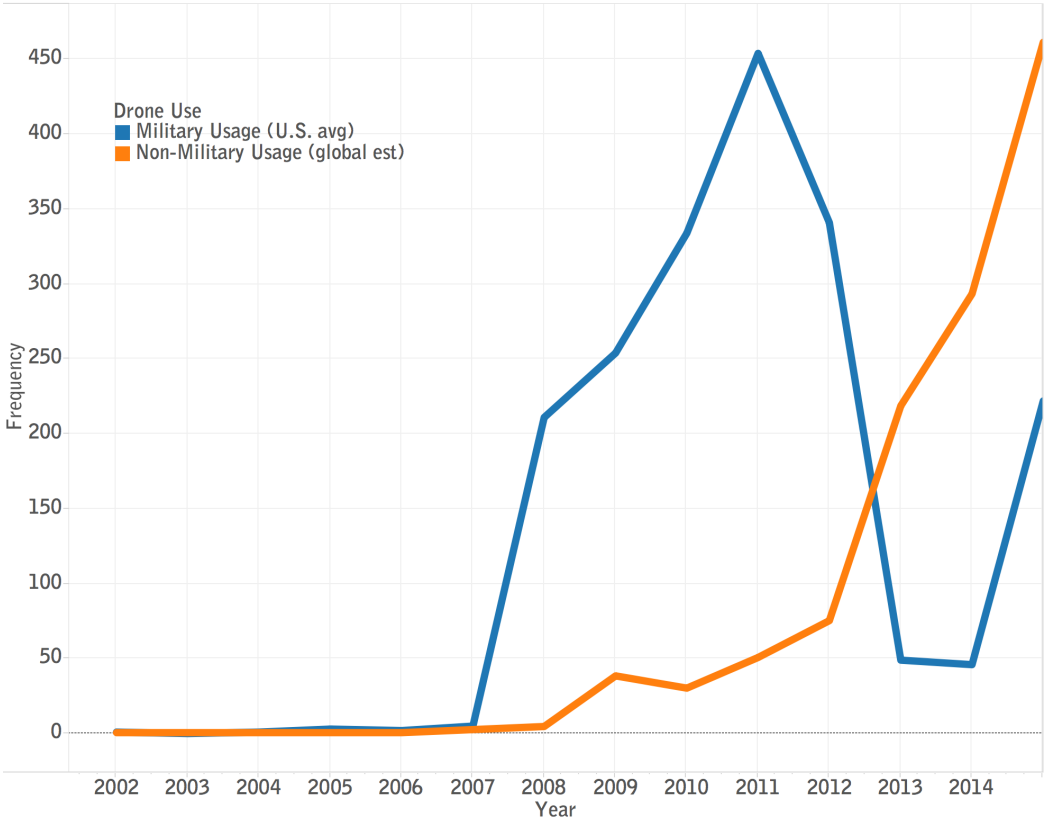


1.2 - Executive Summary

The use of unmanned aerial vehicles (UAVs), or drones, has increased dramatically in recent years. While most attention has gone to military drone use, commercial drones have gained widespread popularity, with uses ranging from leisure activities by hobbyists to humanitarian aid and disaster relief support by non-governmental organizations (NGOs) and activist groups. This use has been hard to quantify and regulate.

In an effort to better understand the rapid growth of non-weaponized drone, this report analyzes cases of worldwide drone use reported during a six-year period (2009-2015). Utilizing a combination of qualitative and quantitative methods, we engage two distinct research questions: (1) what is the nature of civilian drone use over time, and (2) what regulatory responses exist to use at the international, state, and sub-state levels. This six-year window generated more than 15,000 news items for analysis, and resulted in a dataset of 1,145 unique uses. The findings are in line with popular reports: drone usage has grown significantly. New platforms in civilian hands are challenging the status quo response of both regulators and human rights groups. While ethical considerations make direct comparisons nearly useless, non-military use has eclipsed military use. This reality poses fresh challenges to national governments, local municipalities, businesses, and individual actors.

Figure 1.2 - From the Predator Era (2003-present) to the Phantom Era (2013-present)



Source: Non-military use drawn from global estimates (2009-2015) gathered by Choi-Fitzpatrick et al (2016). Military uses drawn from drone strike averages in Afghanistan, Pakistan, Somalia, Yemen, Iraq, Syria, and Libya, as estimated by Long War Journal, New America Foundation, and The Bureau Investigates and compiled by Lars Almquist.

1.3 - Introductory Overview

In April 2015 a 7.8 magnitude earthquake struck Nepal, killing more than 9,000 people and displacing over one million. The quake triggered several aftershocks– the strongest at a 6.7 magnitude–killing an additional 400 people. The damage overwhelmed local authorities and emergency units and foreign aid poured into Nepal from hundreds of governmental and non-governmental organizations and agencies. One of the most innovative contributions came from the Humanitarian UAV Network, also known as UAViators. First responders deployed unmanned aerial vehicles (UAVs or drones) to provide vital and real-time information to rescue teams. Their drones flew below the cloud cover and around physical debris, allowing teams to locate and rescue victims.

Perhaps surprised by the sudden emergence of this new technology, the Nepalese government moved quickly to limit drone use to emergency-effected areas. This restriction on camera-equipped drones emerged in response to a fear that "sensitive information might be leaked and pictures of its valuable heritage sites [taken] illegally." The government suggested historic artifacts were at risk if photographed and police spokesman Sarvendra Khanal suggested that drones had been used to illegally photograph Nepal's heritage sites. Early accounts mistakenly reported that Nepal was banning drones entirely, something other countries had also done in reaction to a perceived loss of control.

The case of Nepal highlights two important themes found throughout this report: small drones are being put to a host of novel uses, and regulators are struggling to keep pace. Drones challenge current regulatory regimes as cameras move to new places—over factory farms or crowds of protesters. Governments are acutely aware of their diminished control over both communication infrastructure and national airspace. National governments are not the only ones facing a disruption of the status quo from UAVs. The number and types of uses and users has grown exponentially—from its roots in the military to a crowd that includes artists, activist groups, academic researchers, and private businesses. The emergence and spread of UAVs, especially in private hands, raises a number of provocative questions. Before these can be answered, however, it is important to establish a baseline of current use. This study is animated by a desire to answer five interrelated questions:

— Is drone use increasing?
— What uses are most prevalent?
— Who is using drones the most?
— Where are drones being used?
— What policies are emerging to regulate drones?

To answer these questions a team with the Good Drone Lab at the University of San Diego analyzed reports of purposeful use by all actors and all types of use except military use in conflict. More than 15,000 individual stories were identified on a number of platforms, including Lexis Nexis, Motherboard, New America, UAViators, and iRevolutions. While a detailed methodology section is included as an Appendix, the general approach was iterative: our team started with a broad set of assumptions about how drones are being used, drawn from the primary investigator's earlier, and more speculative, work.[iv] It quickly became clear that actual usage was far more diverse than anticipated. This report highlights major trends, though its purpose is to provide a general overview to the dataset, which we encourage the reader to download and peruse.[v]

This report is divided into two broad categories. The second section of the report focuses on drone users worldwide (section 2.1), finding that Governments are the largest users of drones, even when excluding military use in conflict. We then focus on drone use globally (section 2.2), and find that Scientific Research, Personal Use, and Conservation uses are the most prevalent, a clear contrast with military uses. In our concluding empirical section (section 2.3), we introduce national-level drone use, with an emphasis on use in English-speaking countries. With these basic facts established, we pivot to the legislative environment.

The third section of the report focuses on legislative trends. At the broadest level, the data suggests that as many as thirty-five countries have recently passed legislation. More specifically, preliminary empirical analysis (section 3.1) suggests that a narrow majority of American states have passed legislation of some sort. The data holds two important lessons: the first is that policy approaches are sporadic, uncoordinated, and unclear. The second lesson is that, despite this uncertainty, several broad regulatory trends are emerging, centered around weight, height, line-of-sight flight, permitting and registration, and no-fly zones.

The report concludes (section 4) with general observations about these findings. It should be noted that the approach taken here is descriptive. The intention is to present empirical data for interpretation by others. This technology will continue to spur both innovation and debate, meaning there is little chance legislative and normative quandaries will be resolved in the near future. Likewise, the evidence provided here is early and illustrative.

1.4 - Typology of Users

Efforts to categorize drone usage face an important issue related to categorization. How can we categorize UAV users? Empirical evidence suggests drone users fall into seven broad categories. While we anticipated several of these categories (e.g., Individual and Government users), others emerged from our data (Science and Academia, for example).

Table 1.1 - Typology of Users

Intergovernmental Organization	Interngovernmental organizational users are those transnational organizations that share responsibility equally among many national governments. This includes the UN and treaty bodies, as well as transnational scientific institutions.
Government	State institutions were coded as government, including governing bodies, military, and the police. Some government use also shades into scientific inquiry, often through university partnerships.
Business	Private for-profit endeavors have long provided the backbone for UAV research and development. More recently businesses have begun exploring how to incorporate UAVs into their business operations.
Science & Academia	More affordable and accessible devices have led to an increase in use by scientific and scholarly communities. This extends from the natural sciences on to the social sciences.
Civil Society Groups	Drone uses by nongovernmental organizations (NGOs), journalists, religious groups, and other civil society groups were considered within one broad category. The function of such groups in society is collective, social, and non-profit.
Named Individuals	We coded the user as named individual for drone uses that were flown by individuals in their capacity as private citizens, rather than representing another user category, although their name was given in the data.
Unknown Users	A significant number of drone uses reported in the data were undertaken by unidentified individuals, meaning existing reports did not record the individual's name. We presume this category describes users who flew the devices for their own purposes.

1.5 - Typology of Uses

These seven broad categories of users put UAVs to a broad array of uses, ranging from commercial activities to advocacy use. We identified these use types through an open coding scheme.[vi] The threshold in this process was the purposeful use of the technology. While described in greater detail in the methods appendix, we define purposeful use as the apparent or presumed goal-oriented behavior around a primary intended action. Behind this jargon is a commitment to identifying why exactly the device was being used.

Table 1.2 - Typology of Uses

Personal Use

"Personal use" indicates all usage undertaken by an individual for no visible material gain, artistic contribution, research objectives, or similar outcome.

Examples: Hobbyist activity, recreational flying

Journalism

"Journalism" includes the broadcasting, collection, and dissemination of information and news. Monitoring, investigating, either as a collective or individual entity to provide knowledge to the public.

Examples: Uses by media sources such as The New York Times, iReporting, Mother Jones, Charlie Hebdo

Environmental & Wildlife Conservation

"Environmental and Wildlife Conservation" includes all efforts to monitor and protect habitats, ecologies, particular species and animals in general.

Examples: Observing wildlife, habitat monitoring, anti-poaching other animal welfare operations

Agriculture

"Agriculture" describes any type of farming or production of foodstuffs through agrarian means. Can also include uses that preserve farmland, crops, etc.

Examples: Pesticide application, monitoring livestock, surveying farmland

Health & Public Safety

"Health and public safety" includes all uses with the assumed purpose of ensuring public health and/or safety.

Examples: Pre-emptive dispersal of medical supplies not associated with emergency services or disaster response, the monitoring or mapping of locations adn events in order to improve safety

Crime

"Crime" indicates uses in which drones are used to achieve an illegal objective.

Examples: Delivering contraband to prison inmates, firing a weapon, terrorism, hacking

Arts & Entertainment

"Arts and entertainment" includes the use and capture of the expression of creative imagination and skill in visual form. This also encompasses the activities, events, or performances designed to provide enjoyment and/or amusement.

Examples: Graffiti via drone, sports and entertainment event coverage, scenic photography & videography, choreography

Social Advocacy & Movements

"Social movement and advocacy" includes efforts by civil society actors used in support of human rights and collective action issues.

Examples: Documenting police-crowd interactions, investigating factory farming, tracking poachers, filming documentaries

Military

"Military" use in this study captures non-weaponized use of drones in support of non-combat operations.

Examples: Supporting humanitarian aid, transport, infrastructure (e.g., mobile WIFI platform)

Commerce

"Commerce" indicates all for-profit drone usage by commercial actors, such as small and large businesses.

Examples: Assistance in construction, health, and delivery services, data collection, for-profit photography

Surveillance

"Surveillance" includes close observation over a designated target or group of targets by government officials and law enforcement as well as private actors.

Examples: Monitoring crowds during riot or protest (by police), individual(s) monitoring private property, spying, peeping toms

Police

"Police" use involves the incorporation of drones into traditional police efforts.

Examples: Monitoring international borders, identifying tax evaders, monitoring riots, surveilling criminal suspects

Emergency Services & Disaster Response

"Emergency services and disaster response" includes uses with the assumed purpose of short-term emergency response and disaster relief, whether or not the State is involved (as is often the case).

Examples: Search and rescue, road surveys, Assistance in responding to natural disasters and accidents

Scientific Research

"Scientific research" includes investigations into the natural world that appear to prioritize "science for science's sake" over industrial research and development, and is often pursued by academic institutions.

Examples: Assistance in meteorological studies, biological monitoring and research, geological and archeological exploration

Other

"Other" describes any other use that does not fit into this category.

Examples: Mapping, peacekeeping

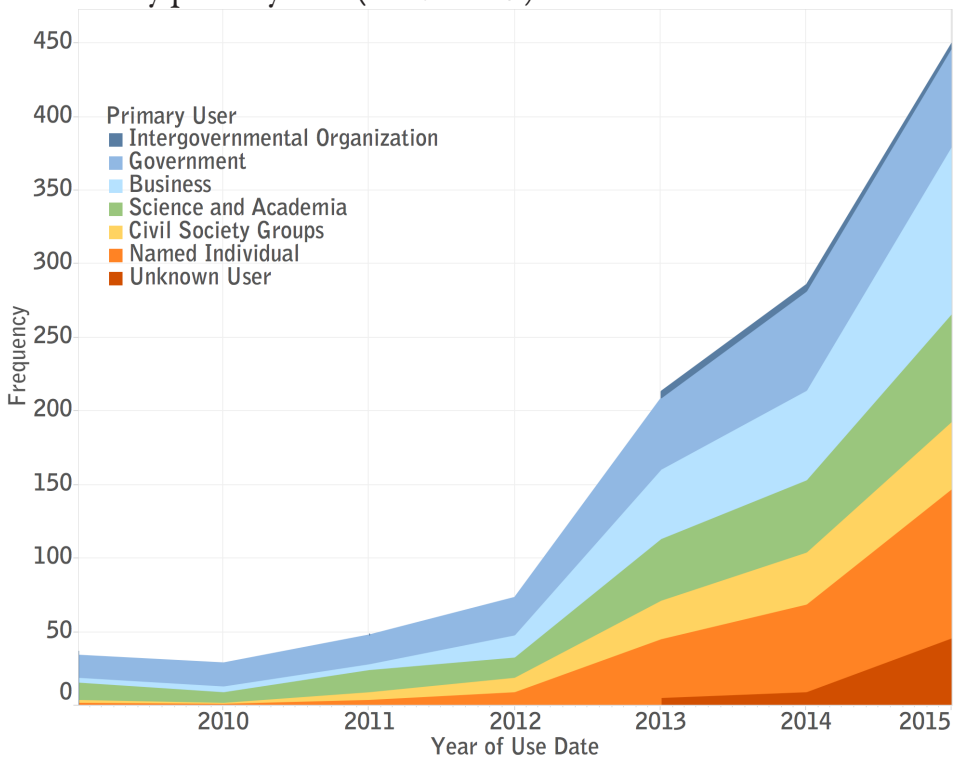
2 - The Data

2.1 - A Global Look at Drone Users

Within the burgeoning realm of non-weaponized drone use, the intentions, aims, and motivations behind such use vary widely. UAVs may be used in much the same way for very different, and even incompatible, reasons. This research was conducted in the midst of a global refugee crisis, as both humanitarian groups and nation-states deployed drones of all sizes to surveille or rescue migrants. For example, the Migrant Offshore Aid Station (MOAS), a Malta-based organization operating out of a converted frigate, has carried two Schiebel UAVs on its rescue boat since 2014. These devices aid in the organization's efforts to locate and rescue migrants attempting to cross the Mediterranean Sea at great risk. MOAS uses the UAV's thermal and night-imaging abilities to carry out its refugee-finding humanitarian mission.[vii]

Half a world away, the Australian government has begun experimenting with the use of drones, responding to issues ranging from national security and territorial sovereignty to monitor the progress of migrants traveling to the continent.[viii] Beginning in 2013, the government announced that drones would operate as a proxy coastguard for the continent. Such drones could also be used to identify attempts to cross the country's borders illegally, targeting asylum seekers fleeing Indonesia by boat, for example.[ix] Domestically, UAV technology is being used to monitor Australia's energy infrastructure and to monitoring brush fires in the outback. The stakeholders and actors who use drones matter. The following section presents the most prominent users and sectors of drone technology: Business Enterprises, Civil Society groups, Governments, Intergovernmental Organizations, named Civilian Individuals, Science and Academia, and Unknown or Unidentified users.

Figure 2.1 - Drone use by primary user (2009-2015)



Government

Singapore's postal service provider, SingPost, is attempting to use drones to deliver mail throughout the small, yet bustling metropolitan nation. Singaporean civilians and small businesses have experimented with using drones, deploying them in ice cream deliveries and even food delivery. Building upon this smaller scale success, SingPost is seeking to facilitate mail delivery using drones, rather than employing personnel on foot. This innovation will enable SingPost to more effectively reach historically less accessible areas, such as Singapore's surrounding islands.[x]

The SingPost innovation is a small example of a broader trend of governments expanding the use of UAVs, making the Government use category the most prolific user of unarmed drones. Government use accounted for 23% (259) of all total uses in our dataset. Like radar, the Internet, and many other technological advances, drone technology and usage were first developed by the state, largely in service of the military, where funding is ample and the drive for innovation is a priority. Reductions in the cost of small, easy-to-operate UAVs and a simultaneous increase in the availability of these platforms have led to a proliferation of civilian-owned drones. Non-weaponized drone use by governments is expected to remain high.

From 2009 to 2014, global use by governments increased steadily, leveling out from 2014 onward. Comparative analysis suggests the most use has been reported in the following countries: the United States (17%, 72 cases), the United Kingdom (24%, 28), Australia (13%, 13), India (60%, 46), Canada (31%, 17), and China (39%, 14). Even though the United States had the most reported government uses by quantity, government utilization in proportion to total use in a particular state was highest in India, where nearly 60% (46 out of 77 cases) of drone use was governmental. The likely reason for this is the Indian government's willingness to use drones to surveille mass gatherings, purportedly for public safety and especially during elections in 2012. Worldwide, it is reasonable to expect that governments will continue to be one of the leading drone users in the coming decade.

Business

Of the more than seven billion inhabitants on the planet, less than half have reliable access to the Internet. Corporations such as Facebook and Google have announced plans to bring Internet connectivity to underserved areas of the world through drones and high altitude balloons.[xi] Businesses, from large corporations to small sole-proprietors, were the second most represented users of drones (22%, 245). The most prevalent intended use in this category is purely commercial activity, such as the delivery services being tested by Amazon and DHL (36%, 88). Additional corporate users include for-profit ventures into the fields of scientific research and health and public safety (12% and 11%, respectively). Should current trends hold steady, Business utilization of drones should soon outpace Governmental use. From 2009 to 2015, the amount of use by business users increased annually. Business-affiliated users represent one third of the total drone use in several countries, including Australia (30% of total drone use attributed to business users) and China (where business users represent a greater percentage of drone use than do private users).

Individual Users

In 2015, Dave Goldstein, Randy Day, and Kastan Day summited Peak 98-54, one of Colorado's highest unclimbed mountain peaks. Complimenting this historic feat was the innovative approach the climbers took: incorporating the assistance of a UAV in the process.[xii] Rigged with a parachute rope, the drone flew to the top of the peak and assisted the group by hoisting the ropes required to successfully summit the peak. Despite outrage from "purists" within the climbing community, the use of a drone to help the climbers make a historic summit displayed an unorthodox and unique implementation of UAV technology in a sport largely void of technological intervention.

Individual users, including recreational users such as the climbers of Peak 98-54 and those using drones to create art, photograph public places, and document public events, represented 19% (217) of the total uses in our dataset. Such users have no known institutional affiliations, but were clearly identified by name in the reports that comprise our dataset. If no name was present, individuals were classified as "Unknown" (5% of our dataset). The majority of Individual users appeared to deploy their drone for unspecified Personal use (32%, 69 cases), and occasionally for Arts and Entertainment purposes (14%, 30). This category of use skyrockets between 2014 (25) and 2015 (86), presumably as consumer-level drones grow in popularity. Major manufacturers like American 3DR and Chinese DJI are collectively selling tens of thousands of units each year.[xiii] This usage is most pronounced in the United States (U.S.), United Kingdom (U.K.), and Canada, where individual users exceed other categories of use starting in 2014. Indeed, combining Unknown users with Individual users—on the assumption that both are performed by private individuals—suggests this category is easily the largest user category in the dataset, representing almost a quarter of all users (24%, 277).

Science and Academia

Scientists in the United States are testing drones in an attempt to offset the collapse of honeybee population.[xiv] Micro-drones configured to operate like small dump trucks of pollen, and working in large numbers, may help pollinate crops alongside their organic cousins while other scientists figure out why bee populations are declining.

Out of the 210 uses categorized as Science and Academia (Table 4), many were for general scientific use (39%, 81). Additional uses are identified in the areas of Environmental Conservation (20%, 42), Agriculture (12%, 26), and Health and Public Safety (11%, 24). The Scientific category covers a wide range of sectors. For example, Scientific use may overlap with research on Wildlife Conservation and Agriculture. It is likely that users from the fields of Science and Academia will continue to incorporate drones into their fieldwork.

Civil Society Groups

In the fall of 2015, tens of thousands of migrants fleeing violence in Syria crossed the Hungarian border and entered Europe. Several years earlier an Australian television program attempted to use a drone to survey an immigration detention center on Christmas Island.[xv] The hexacopter successfully captured images of the camp, triggering an investigation by Australian authorities. Reported usage by Civil Society groups is relatively small in our sample (11%, 125) and has declined over the period covered in this study. Civil Society use includes Emergency Services (18%, 23), Environmental and Wildlife Conservation (20%, 25), and Journalism (10%, 13).

The varying degree of drone usage by Civil Society groups reveals a diverse range of data, likely mirroring the expansive range of particular agendas and interests represented by civil society itself. Drone adoption by civil society lags behind actors who have greater financial access to consume new technology. Resources might not be the whole story, however, as many non-profit organizations may be opposed to utilizing drones because of their association with military uses. Organizations may also be reluctant to use technology that raises complex questions about privacy. Growth among Civil Society users has been moderate, though there is every reason to expect usage to grow, especially among activists willing to push the boundaries of advocacy journalism.

Unknown Users

When news first broke that a small UAV crash-landed on the grounds of the White House, the operator had already vanished, unknown and unidentified. The significance of the crash site ensured that the pilot would quickly be apprehended,[xvi] but many other uses (and some crashes) are reported without ever identifying the pilot by name or institution. A little more than five percent (5.3%) of all users in dataset went unidentified. These were mainly incidents where the user was not named, but the use was deemed newsworthy (i.e., a drone flew over a local high school football game, frightening the band and leading to a stampede of colorful outfits and shiny instruments).

Nearly all such instances (83%, 51) represented Personal use, rather than Commercial or Scientific purposes. However, it is difficult to determine motives for such users. This segment of the data is undoubtedly the least robust, as most flights are unremarkable in terms of meriting journalistic or other documentation and most users relatively anonymous. As civilian access to UAVs continues to grow, there is every reason to anticipate that such flights will become more common, with documentation of such uses waning as drone use enters mainstream activity. The number of future reports would then be inversely related to actual use.

Intergovernmental Organizations (IGOs)

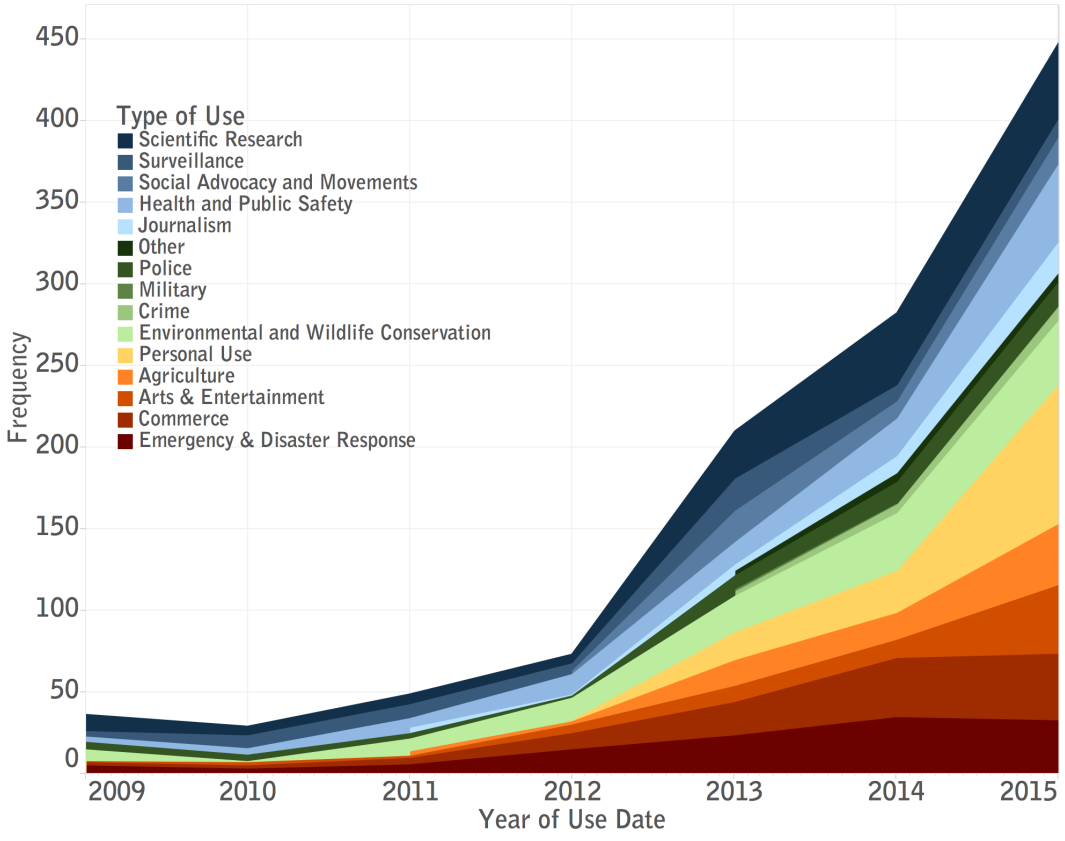
As UN peacekeepers began pulling out of the Ivory Coast after a decline in armed conflict, large, fixed-wing unarmed drones were suggested as a replacement.[xvii] This use was not followed by an upward tick in peacekeeping drone use, though institutions like the International Criminal Court

are quietly purchasing devices for in-house testing. Indeed, Intergovernmental Organizations were the least frequent users in the dataset, at just over one percent (1.4%, 16 user events). The peak of IGO use came in 2014 with a modest handful of cases. These five cases represented 33% of all reported IGO use in the data. Interestingly, all of those were drone uses facilitating the delivery of emergency services and responding to natural disasters in situations such as the Balkan Floods and Cyclone Ita's striking of Queensland, Australia. There is every reason to believe this category of usage will surge in the upcoming decade, especially as newer, tech-savvy and forward-thinking advocacy groups mainstream drone usage.

2.2 - A Global Look at Drone Use

A cursory review of the data reveals drones being used by many actors and for a seemingly endless number of uses. Falconers in the United Arab Emirates use drones to draw falcons to higher vantage points. Scientists operate UAVs to survey land and identify geological features and formations. Meanwhile, access to drones is transforming the investigative efforts of everyday activists. In order to more clearly depict the diverse array of drone usage represented in the large amount of data gathered for this report, usage has been divided into fifteen distinct use-types. Detailed descriptions of these uses may be found in the Appendix. The following pages will highlight the trends within the eight top use-types:[xviii] Scientific Research, Environmental and Wildlife Conservation, Commerce, Personal, Emergency Services and Disaster Response, Health and Public Safety, Police, and Surveillance.

Figure 2.2 - Drone use by primary use type (2009-2015)



Scientific Research

Scientific Research is the most prevalent use, representing 17% (191) reported instances.[xix] Uses designated as Scientific Research refer to academic investigations that lend insight into phenomena of the natural world. Instances labeled as scientific research include developing drones that have multiple capabilities, including: identifying dinosaur tracks, monitoring coastal areas for erosion and wildlife behaviors, and surveying ice temperatures and geological conditions in preparation for China's first airport in the Antarctic. Likewise, drones have been used to research how biological organisms live on substrates in volcanic areas, which may help understand how life could have evolved on other planets. As science and academia operate at the forefront of civilian-based drone technology, it is reasonable that the data shows Scientific Research as the highest category of reported use.

Environmental and Wildlife Conservation

The second most documented drone use involves the monitoring and protection of ecosystems (14%, 158). The period from 2010 to 2015 reveals a steady increase: in 2010 conservation activities represented only 3.4% of reported drone use, but rise to 16.3% in 2011 and 19.2% in 2012. This increase includes the work of researchers like Martin Israel.[xx] Israel has used a drone-based infrared camera to detect animals hidden in tall grass. The animals are often harmed or killed by mowing operations in Germany and Austria and such a detection systems could eliminate some of these fatalities. Other uses range from monitoring wild yaks in China[xxi] to documenting glacier movements in Greenland.[xxii]

Commerce

Commercial activity generates the third highest incident rate, with a total of 157 drone uses. Both small and large businesses are using drones in their economic ventures. In 2009, reported drone uses related to Commerce made up only 5.4% of total reported primary uses. By 2012, however, Commercial use had risen to 13.7%. As businesses continue to integrate technological advances into their manufacturing processes and delivery services, it is likely that drones will continue to alter and, perhaps, enhance business performance. Media attention has focused on prominent corporations, such as Amazon and DHL, which are both testing drones as package-delivery systems.[xxiii] Delivery drones are only one of many possible Commercial uses, however, as UAVs are additionally being used for infrastructure construction and maintenance, advertising and marketing campaigns, commercial sports documentation and various roles in the entertainment industry.

Personal

Personal use represents the fourth most documented usage category, totaling 12% (139) of drone uses. Technological advances in UAVs from companies like DJI and 3DR have largely driven

the rise in personal drone use through the production and marketing of easy-to-fly consumer drones, beginning in late 2012 and early 2013. Chinese manufacturer DJI increased its civilian drone sales from $4.2 million in 2011 to $130 million in 2013, largely due to the popularity of its Phantom device, which was released in 2013.[xxiv] Additional examples of Personal drone usage range from individuals taking pictures of wedding ceremonies, concerts, and sporting games to the recreational flying of drones in various locations.

Law Enforcement

Law enforcement has begun to incorporate drones into traditional policing practices, as evidenced by the 124 reported uses in this study (11% of total reported use). For example, Indonesian authorities have used drones to catch mining and plantation companies that have avoided paying taxes. Likewise, government aids in Nigeria have used drones to search for missing girls kidnapped by the Islamist extremist Group, Boko Haram.[xxv] Reports of law enforcement drone use were relatively common in 2009 and 2010, with reported instances climbing into double digits. However, in the starkest inversion of drone usage trends found in this dataset, reports of law enforcement drone utilization plummeted between 2011 and 2015. This variation is likely due to legislation restricting police related drone use, as seen in the following section on regulatory responses. The Law Enforcement category is one of the only areas where this report anticipates increasingly complicated patterns of use, as new public policies either enhance or forbid police use. Law enforcement's use of drone technology, particularly in the tenuous contemporary political environment surrounding government surveillance and largely unchecked law enforcement coercive activity in the United States. This debate will transform future UAV policies. It is not clear how this process will play out, but it is likely that any law enforcement acquisition of UAVs will happen on a piecemeal basis.

Emergency Services and Disaster Response

The deployment of drones in the context of short-term emergencies and disasters accounted for 12% (138) of the total uses in the dataset. Frequency of such use was relatively consistent from 2009-2011, but increased dramatically in 2012. This increase may relate to the number of natural disasters in that year, including Hurricane Sandy impacting the United States' east coast, a magnitude 8.6 earthquake striking Indonesia, and a series of deadly typhoons striking the Philippines. Drones may be used in post-disaster monitoring as well. For example, they were used to test radiation levels at the site of the 2011 nuclear disaster site in Fukushima.[xxvi] While these examples of emergency drone deployment occurred in the context of massive disasters, UAVs may be used for smaller-scale emergency service missions, such as equipping drones with thermal imaging cameras that may aid in search and rescue missions or investigating serious automobile crashes. Such uses are likely to increase in the future, particularly once local regulations clarify appropriate use by emergency responders.

Health and Public Safety

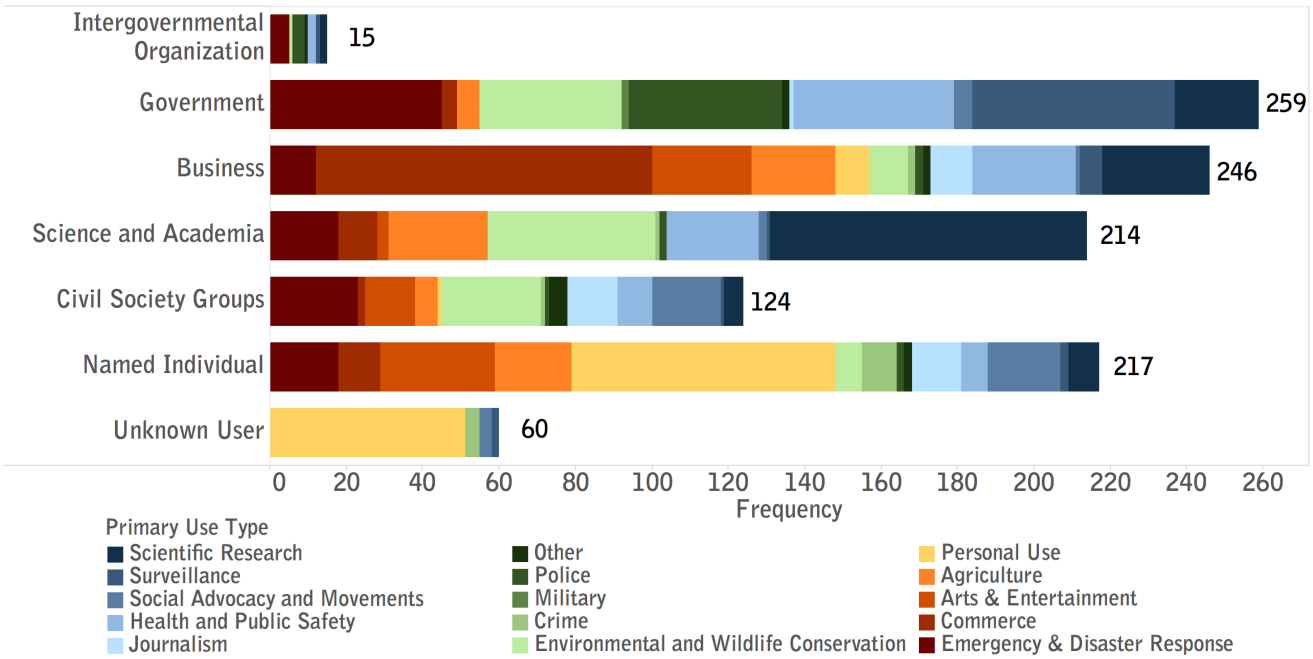
Health and Public Safety use has risen considerably during the period of study, for a total of 10% (110) of total use. In 2009, health and public safety made up 8.1% of total reported uses. This figure roughly doubled to 16% of identified uses in 2012. Professor Vijar Kumar has highlighted the technology's potential, noting the devices may "be sent into collapsed buildings, to assess the damage after natural disasters, or sent into reactor buildings, [and] to map radiation levels." Greater accessibility to consumer drones and greater attention to their innovative potential may also have contributed to the increase in health and public safety reported uses.

radiation levels."[xxvii] Greater accessibility to consumer drones and greater attention to their innovative potential may also have contributed to the increase in health and public safety reported uses.

Surveillance

Drones are increasingly used by state and non-state actors to surveille individuals and groups, as indicated by the 108 documented surveillance uses in the data (9%). Surveillance has, and continues to remain, a debated use for drones, especially with regard to privacy rights. Drones enhance the surveillance capacity of law enforcement and governments, though there is no consensus on how to regulate such use, to say nothing of enforcement of these regulations. This study includes instances of drones monitoring the American-Mexican border,[xxviii] of the American animal rights organization People for the Ethical Treatment of Animals (PETA),[xxix] and of police drones in India surveying crowds during rallies and riots.[xxx] Likewise, drones have been employed in China to monitor cheating during the National College Entrance Examination.[xxxi] While some of these uses will prove to be unsustainable, it is reasonable to anticipate Surveillance will represent an area of ongoing innovation and debate, with governmental users at the forefront of such use.

Figure 2.3 - Types of primary use by primary user type

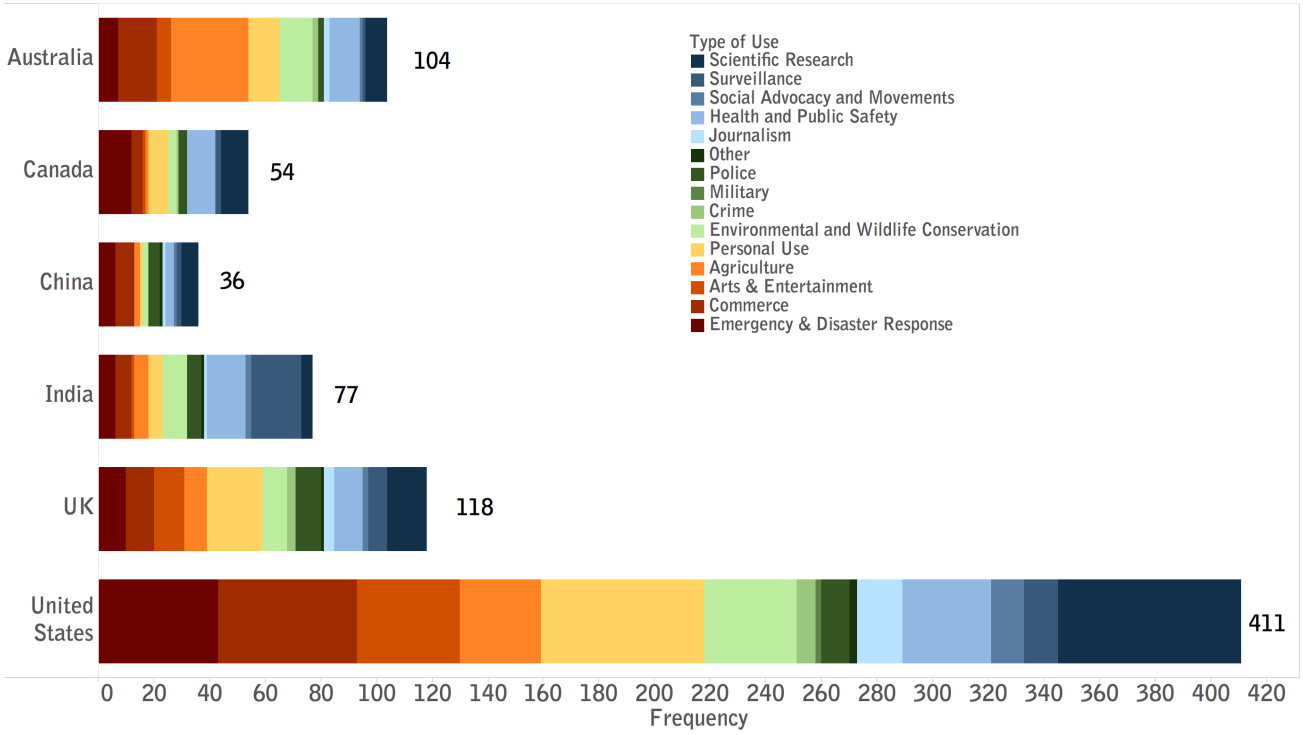


The following section explores the ways these uses unfold at a national level. Within the six top countries of total recorded drones use, "Business" represented the greatest usage category in both the United States and United Kingdom, while "Government" represented the main usage category in India China and Canada. Rounding out the top six, "Business" and "Government" tied in peak usage. While the specific applications of drone use in each country differed, the reality that government and business represent primary users in the top six may be indicative of industrial and governmental initiatives leading UAV proliferation. Increased civilian access to affordable drones may affect this trend in future years.

2.3 - A Global Look at Country-level Drone Use

This report finds the greatest usage in the United States, followed by the U.K., Australia, India, Canada, and China. The prominence of the United States' role may be due to a number of methodological and accessibility issues. Methodologically, this study focused narrowly on English-language reports, which likely skewed resulting usage reports to countries where English language reporting is standard (such as in the United States, the U.K., Australia, and Canada). Additionally, the presence of thousands of American technology journalists and bloggers reporting extensively on innovation likely skew the data toward U.S.-based drone usage. Economically speaking, the United States' large consumer market features two facets that may disproportionately cultivate increased domestic drone usage. The first is the sheer number of civilians with the purchasing power to acquire UAVs. The second is found in the greater number of technology-focused entrepreneurs and startups than in the U.K., for example.

Figure 2.4 - Top 6 nation users and their primary uses



A number of factors deserve mentioning. There is clear national-level variation based on local norms with regard to privacy and property. Additional variables, such as land and population density, contribute to this variation as well. State capacity and national policies toward innovation may also be part of the story here. National legal traditions matter as well, as both the United Kingdom and India appear to be more willing to deploy drones for surveillance purposes than do the United States and Canada, for example. Perhaps surprisingly, less drone use was reported in China, however, this may be the result of the methodological issues mentioned above, rather than actual drone usage.[xxxii]

United States

The United States is home to more than one third of total reported drone usage (36%, N%). Weaponized drones have had a large cultural, political and military presence due to their use by the CIA in the "war on terror." This study suggests that the United States is home to a second wave of innovation, this time around smaller devices being used by non-specialists. Our data suggests drone use of all sorts began to accelerate in the United States after 2012. Since 2012, drone use has increased exponentially almost across the board (with the exception of Environment and Wildlife Conservation, which dipped in 2015). In the U.S., the top three categories were Business (24%, 99 cases), Science and Academia (21%, 88), and Individual use (22%, 90) (Table 19). Compared to other countries, the U.S. appears to have more Personal use (14%, 59), Commercial use (12%, 50), and Scientific Research application (16%, 66) than any other country during the period of study. Trends suggest a continued increase across all categories, but especially in Personal use and Commerce. Surveillance usage may stagnate or even decline in the coming years, as complex regulatory issues wind their way through local and national jurisdictions. Personal use is likely to grow as manufacturers lower prices and new regulations make civilian drone use relatively acceptable (not to mention the difficulty in enforcing applicable drone regulations upon individual UAV operators). Current data suggests the U.S. will set the pace for future civilian drone use as it has already done for military drone use.

United Kingdom

The U.K. has the second highest total reported uses (10%, 119 cases). Like the U.S., the United Kingdom experienced a slow increase in use from 2009 until 2012. While every year after 2012 experienced some growth in one category or another, only a handful demonstrated relatively consistent growth. Commercial and Personal use have increased tremendously, with a rapid increase in other usage categories, such as Environment and Health, have grown drastically since 2014. In contrast to the United States, 2014, rather than 2012, is the breakthrough year for drone usage in the U.K. However, the same year saw a decline in both Agricultural and Commercial usage. Missing data may be the likely culprit for these trends, as it is unlikely, for example, that personal use was negligible prior to 2014. In 2010, the Civil Aviation Authority (CAA) stipulated

regulations requiring UAV commercial operators to obtain permission from the CAA. Non-commercial uses must adhere to industry standard regulations related to height, distance, and proximity to airports and other key areas.[xxxiii] Despite likely underreporting, there is clearly an upward tick in 2014, a two-year lag on the United States. Without more representative data, it is difficult to determine sub-trends within the data beyond this general increase.

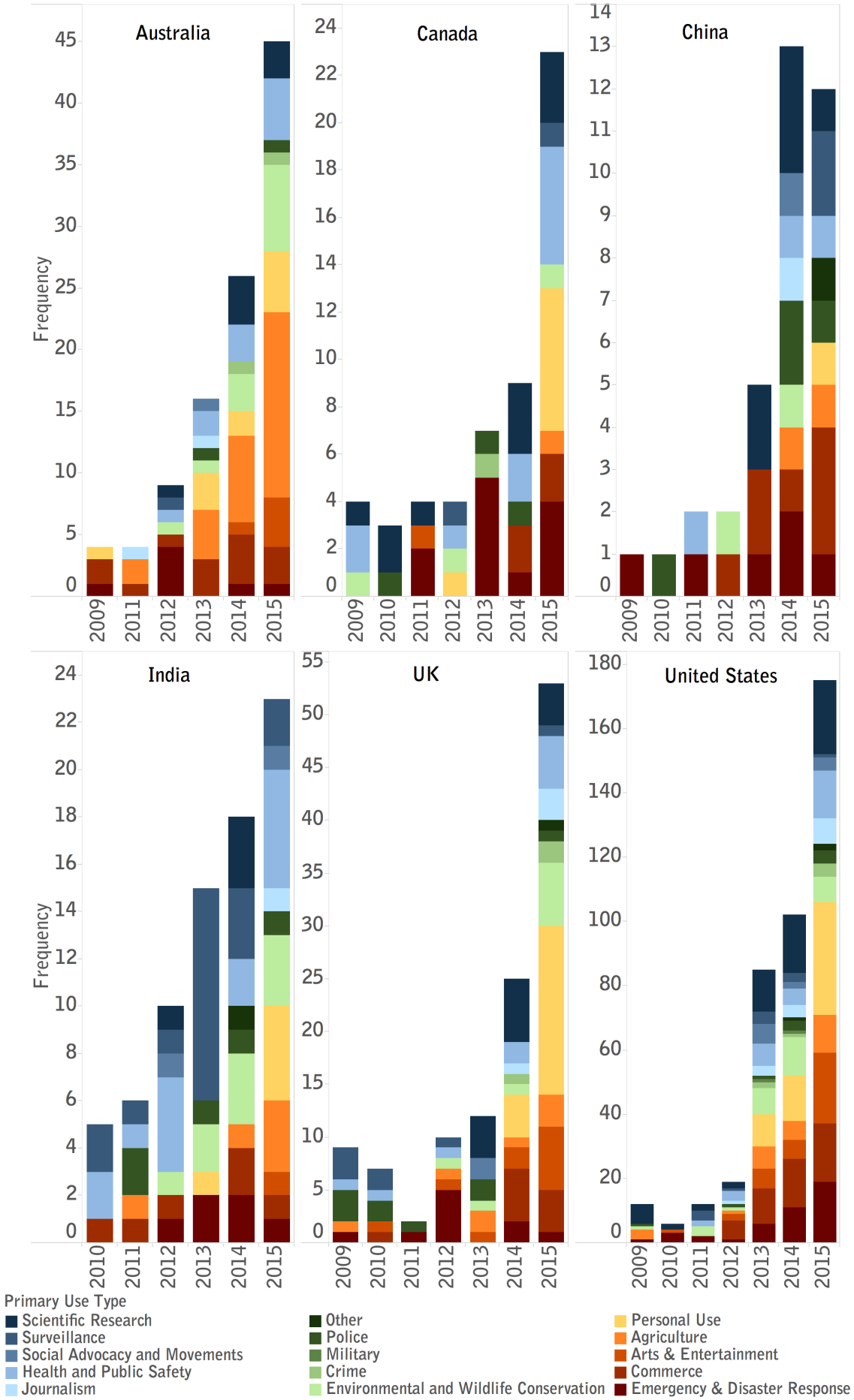
Australia

Compared to the United States and the United Kingdom, all categories of use have shown a slow but gradual increase in the use of drones in Australia, except Emergency Services and Commerce. It appears users in Australia are more invested in Agricultural use (27%, 28 cases) and Conservation uses (11%, 12). These findings make sense, as Australia's vast and open terrain is perhaps better surveyed by drone than by foot or vehicle. The country's large agricultural sector and progressive environmental policies provide additional rationale for Australia's increased drone use in these sectors. Unlike the U.S. and U.K., there are only small increases in Individual use or Commerce, despite similar market and regulatory conditions, and despite similarities in news reporting. Emergency Services in particular saw a decline of drone use over time, peaking in 2012 with four uses. Similarly, Law Enforcement use is almost non-existent in Australia (only two uses) when compared to the United States and India. Given the continent's size, it seems reasonable to anticipate that usage in the Agricultural and Environmental sectors will remain stable, if not increase. Individual use is also likely to grow with greater access to drones, as proposed legislation specifies that no permits are required for small devices (< 2kg) used during the day, below 400 feet, within a line of sight, and away from important areas (vehicles, others' property, airports).[xxxiv]

India

India ranks fourth for reported drone use in the world (7%, 77 cases). India's sporadic drone usage is likely the result of low civilian usage, data collection problems, and an underdeveloped consumer market for drones. India has far fewer of the 16 usage types compared to other leading countries, meaning that lower total usage is complimented by a lack of variety in existing usage. Nevertheless, a few uses exist, and each has generally increased over time, with the exception of Surveillance and Health and Safety use, which spiked around national elections. The relative surge in Indian drone use in 2013 corresponds to the start of the general election cycle. In the lead up to the largest democratic election in the world, the Indian government deployed drones in order to monitor large political rallies, to gather intelligence on crowds, to survey assemblies, and to monitor Maoist rebels in various parts of the county. Drone use drastically reduced after the end of the general elections in 2014. As Governmental drone use waned, other usage categories emerged. Specifically, Personal use, Agriculture, and a rebound in the Health and Public Safety category can be seen moving forward into 2015. On the regulatory front, all non-governmental drone flights in India have been forbidden by a General of Civil Aviation-issued statement running all of one

Figure 2.5 - Primary use type of top 6 national users (2009-2015)



page and identifying "security threats" and congested airspace as motivating factors for the decree. Future assessments should take seriously the fact that the grounding of non-governmental drones has combined with a willingness to use this technology to surveil collective action efforts like rallies and protests. Whether this is an outlier or harbinger remains to be seen.

Canada

Canada's drone uses mirrors that of the United States, but on a much smaller scale (5%, 55 cases). As in other countries with well-developed consumer markets (i.e., the U.S. and U.K.), Personal use took off in 2012 and shows no sign of abating. As in the U.S., Emergency Services use has ebbed and flowed up through 2013, dipping in 2014, and then back up again in 2015. This rise and fall was similar to trends in the United States in the same period of time. While Canada's geography, like Australia's, would appear to encourage more of both Environmental Conservation and Scientific Research usage, this does not appear to be the case. On the regulatory front, Canadian regulators have determined that the recreational use of devices under 35 kilograms (a relatively large device, up to 77 pounds) are subject to safety guidelines, but do not require operating permission from regulators.

China

Although there is insufficient data to make solid generalizations (4%, 36 reported cases), it appears usage in China is growing. At present, drone use appears to be mainly in the hands of the Chinese government, with 39% of all reported drone use categorized as Government. Methodological reporting issues surely account for undercounting of Chinese drone use, as the media represents the most visible source of reported drone use. Given the nature of a state-controlled media apparatus in China, combined with research queries conducted in English, this report recognizes that there is significant room for growth in both data acquisition and representation when it comes to countries such as China. Existing data makes it possible to infer there is more drone use occurring in China than is portrayed at present. However, it is difficult to anticipate precisely how drone usage is growing. Oversampling from Chinese language sources would certainly assist in this endeavor. The regulatory environment in China appears to be in flux as well, as the State seeks to balance safety and security with the growth of the UAV industry.[xxxv]

3 - Legislation

The diverse capabilities demonstrated by drones have solidified UAVs as a key aspect of contemporary technological advancement. Legislation governing drone use, while diverse in scope and application, has struggled to keep pace with advancements in the field. This subplot in the relationship between law and technology is especially apparent in the sub-state legislative arena. In countries such as the United States, sub-state legislation refers to non-federal policies enacted at the state or municipal level. This level of UAV-related legislation will continue to be defined by legislators in communities like Poway, California, as local leaders seek context-appropriate regulations for new and proliferating technologies. "We aren't opposed to this technology," says Poway's Mayor, Steve Vaus. "We're not trying to hamper it or hold it back. Just don't get in the way of emergency operations and it's all good."

At the international, state, and sub-state level, there is little consensus on regulation, let alone enforcement. This section discusses all three regulatory levels, highlighting an overall lack of conformity punctuated by a few early findings. The recent surge in civil society drone use has prompted a scramble by federal, state, and sub-state legislatures to define and regulate acceptable and legal drone use. In the United States, the Federal Aviation Administration (FAA) permits individuals (and some commercial actors) to use drones so long as users register their aircraft and comply with certain restrictions. The FAA's nascent attention to civilian UAV use reflects legislative uncertainties more broadly. Despite these uncertainties, broader regulatory trendlines are emerging, as evidenced by a mandatory registration system for UAVs in the United States that began in December 2015.

3.1 - Trends in International Legislation

Comprehensive information is difficult to obtain at the international level. Nevertheless, this report estimates that between 40 and 50 countries have some form of legislation related to UAV use, with the most policy action emerging in the past five years. Preliminary analysis suggests that the majority of these policies (35-40) have been introduced quite recently. For example, commercial drone use is forbidden in Belgium and India, yet allowed in a host of other countries, though with a wide range of requirements for such use. China does not have a nationwide drone policy (though the mayor of Shanghai has issued a no-fly zone over the city).[xxxvi] South Africa has been on operators' radars since advocacy groups announced poachers would be tracked by the devices. The government responded by grounding all drone use, and later loosening the restrictions somewhat (though still forbidding flights higher than the tallest building and trees).[xxxvii] These brief examples suggest it will be quite some time before coherent and consistent regulations emerge.

3.2 - Legislative Trends in the United States

The mandatory registration of all UAVs weighing between .55 and 55 pounds went into effect in

December, 2015. More than 300,000 civilian straightforward: owners provide their name, address, and email address, pay a small fee, and receive a registration number that is valid for three years. All UAVs owned by the registrant must then be properly marked with the registration number. The ruling outlines both civil and criminal penalties resulting from a failure to register. Advocates of civilian drone use have noted that the registration system does not reflect a user's ability to safely fly a UAV, but simply allows the identification of a user in the event of an accident or criminal use of a drone.[xxxviii] The FAA also outlines permissible hours of flight, line-of-sight observation, altitude, and other operational limits. A smartphone application called B4UFLY,[xxxix] as well as a website, knowbeforeyoufly.org,[xl] are available to inform UAV users of registration requirements, flight restrictions, etc.

Following the guidelines of a Fact Sheet released by the FAA, federal regulations also govern commercial, non-recreational or non-hobby operation of UAVs, often referred to as unmanned aerial systems (UAS), which specifies the inclusion of all support equipment. Importantly:

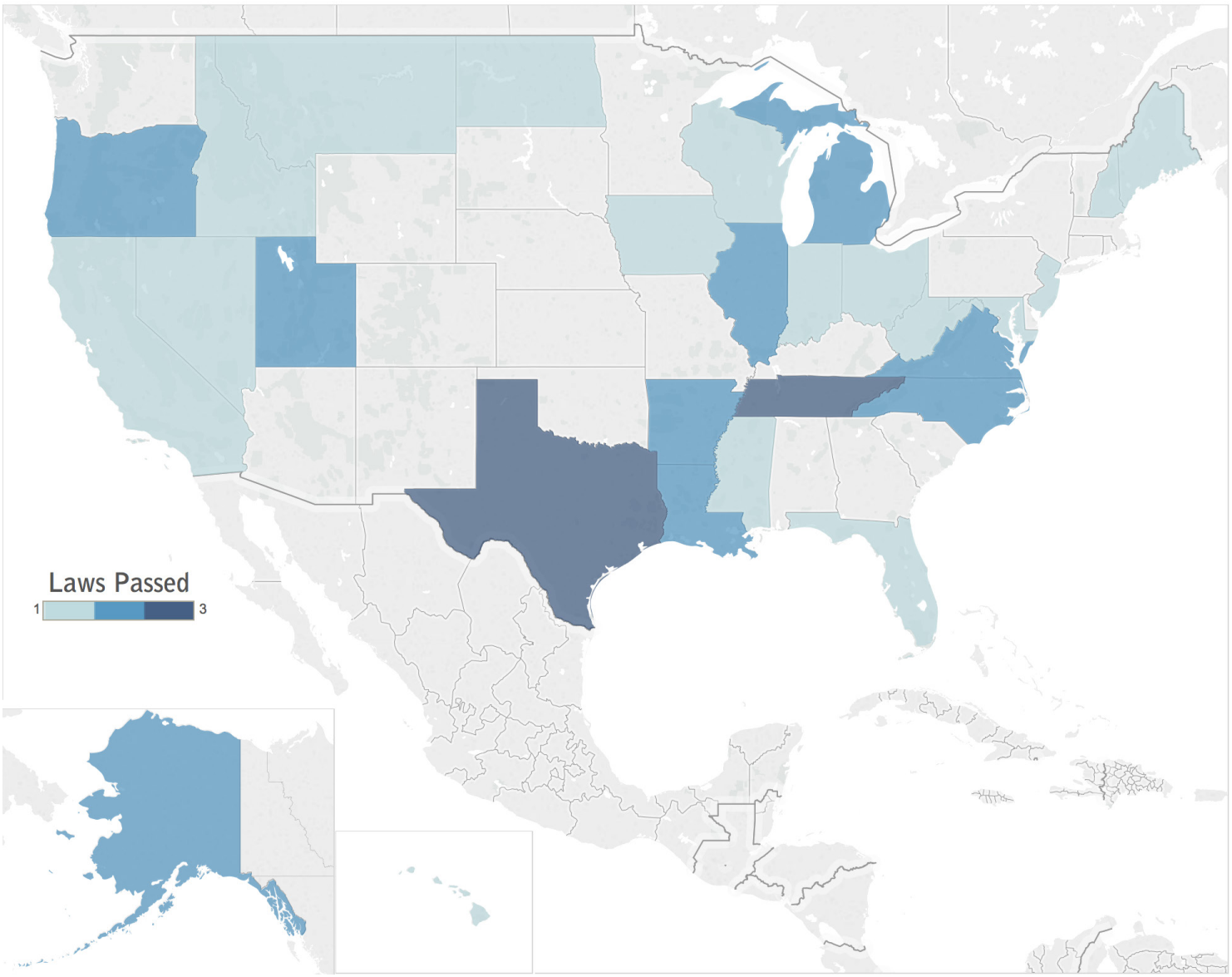
> *"no state or local UAS registration law may relieve a UAS owner or operator from complying with the Federal UAS registration requirements. Because Federal registration is the exclusive means for registering UAS for purposes of operating an aircraft in navigable airspace, no state or local government may impose an additional registration requirement on the operation of UAS in navigable airspace without first obtaining FAA approval."* [xli]

This is the most recent and accessible indication of the FAA's intent to prevent "fractionalized control of the navigable airspace," in which a "patchwork quilt" of varied restrictions might hamper the FAA's ability to control airspace and flight patterns, inhibiting the safety and efficiency of air traffic flow. In the FAA's view, "A navigable airspace free from inconsistent state and local restrictions is essential to the maintenance of a safe and sound air transportation system."

Accordingly, the FAA recommends coordinating state and sub-state legislation. More pointedly, "federal courts [will] strictly scrutinize state and local regulation of overflight." The FAA does note that, "Laws traditionally related to state and local police power – including land use, zoning, privacy, trespass, and law enforcement operations – generally are not subject to federal regulation."[xlii] These include many of the laws noted in the sub-state portion of this section, such as those related to law enforcement surveillance, voyeurism, and prohibition of weaponized drones.

At the state level, drone legislation remains scattered. Currently, 41 state laws on drone usage have been passed by 28 of the 50 states. While this may seem like a substantial number, these policies are piecemeal and uncoordinated. Twelve deal with drone use by law enforcement, five address state legislative task-forces dealing with drones, ten restrict unauthorized surveillance using a drone, and six ban hunting with a drone. While some approaches show some promise, no model legislation has been forthcoming.

Figure 3.1 - Passage of Drone Legislation based on State



Of the 41 drone laws in the United States,

12 Deal with drone use by law enforcement (i.e. police can only use drones if they have a warrant)

10 Restrict or criminalize the act of unconsented drone surveillance

6 Restrict or ban the act of hunting with a drone, one regulates the use of drones in commercial agricultural operations

5 Deal with the expansion of state legislative task force powers on drone-use or the creation of a drone-committee

4 Criminalize the act of using drones to harm others, or fly over critical infrastructure facilities

In addition to these 41 laws, 2013-2015 saw an additional 21 state drone legislation proposals. Eighteen of these laws were rejected by state legislation, with the final three remaining unresolved. The lack of progress in passing state-level legislation speaks loudly to the ambiguity of what constitutes 'acceptable' and 'legal' drone use in the United States.

3.3 - Sub-state Legislation

In the United States, more than two dozen cities have passed laws regarding drone use. There has been substantial variation among municipal measures related to UAVs, though several trends are apparent. Sub-state legislation reveals distinct typologies in terms of who is being regulated. Cities have usually focused on either potential municipal misuse use of drones or civilian drone use generally. Attention to potential municipal misuse of drones was initially popular at the sub-state legislative level, though more recent legislation at this level has largely focused on restricting civilian use of drones, a trend that is likely to continue. It is also important to note that drone-related legislation has been discussed at length in many cities that have yet to pass specific legislation. Some are still debating the appropriate measures (as in New York City), while others have tabled such discussions in anticipation of federal regulations that will be established at the time of this study's conclusion.

3.4 - Sub-state Legislation: Restricting law enforcement

Several cities adopted legislation in early 2013 that focused specifically on the state's use of drones. These included restricting the use of information obtained from drones in court cases, as well as law enforcement's use of drones with any capability to harm, incapacitate, or otherwise negatively affect a human being. More pointedly, Syracuse, NY banned law enforcement and other official use of drones as of 2013 in the absence of a legal framework that adequately protects the privacy of the population, noting that:

> *"unlawful use or sharing of the data collected by drones would represent an unreasonable and unacceptable violation of individual privacy, freedom of association and assembly, equal protection and due process in the City of Syracuse and guaranteed by the First and Fourth amendments to the Constitution."* [xliii]

Some cities, such as Northhampton, MA have called on the federal government to end drone surveillance and "extrajudicial killing by armed drone aircraft," and have drawn attention to drones marketed to domestic law enforcement that are "designed to carry weapons" as indicative of "a chilling message to the American people."[xliv] Legislation of this type has waned dramatically, as discourse at the sub-state legislative level is now dominated by concerns about the proliferation of civilian drones.

3.5 - Sub-state Legislation: Civilian use of drones

A few cities instituted "peeping-tom" ordinances in 2013 and 2014, which banned civilian drone use according to privacy concerns, though each allows for various municipal uses. More recently, some have passed site- or day-specific bans relating to football games, the visit of a holy dignitary, or other large amalgamations of people. Since the FAA regulates airspace, sub-state regulatory frameworks commonly specify parameters that are loosely based on FAA guidance for the "model" aircraft flown by hobbyists. These restrictions ban flights around airports, near stadiums, above 400 feet in altitude, etc.[xlv] For instance, in November 2015, in what has been pitched as a particularly comprehensive regulatory framework, the city of Chicago instituted civilian no-fly zones around airports, police departments, schools, churches, hospitals, and private property without the owner's permission.[xlvi]

3.6 - Regulatory trends

Drone legislation at the national, state, and sub-state levels is still a trial and error affair, and a systematic approach to regulation has yet to emerge. Three broad trends can be identified, however: free flying, total grounding, and regulated use.

Free Flying describes jurisdictions that have either not passed pertinent laws yet, or have specifically legislated the allowance of civilian drone flight.

Total Grounding describes jurisdictions that have had a reactionary response to civilian drone flight and have sought to make proactive decisions regarding their use.

Regulated Use describes jurisdictions where these first two types have been replaced by some combination of the following factors:

1. Weight - New rules tend to apply to newer and lighter devices (usually under 2kg, but under 7kg in Denmark and Malta; Sweden has adopted a unique approach that takes into account the kinetic energy of the drone).
2. Operator - Certifying the operator may be done through a combination of health checks, basic registration, and/or health checks. Operators must be sober and of a certain age.
3. Height - Flight ceilings are often set at 400 feet, but sometimes extend as high as 500 (Portugal), and as low as the highest building or tree (South Africa).
4. No-fly zones - often set around airports and other sensitive areas. Many ordinances specify that drones may not be operated within certain areas. This may apply as broadly as entire cities, or be restricted to more specific instances, such as over crowds at events.
5. Visual Line of Sight (VLOS) - Most countries require the operator to be within a line of sight with the device.

In terms of state and sub-state legislation, laws on drone use often adopt most, if not all, of the variables found in national regulations. For instance, small towns have specified height restrictions at lower points than the national mandate. While national legislation on drones is often quite general—restricting the size, height, location of the drone—state and sub-state laws are often more specific, as most address issues on public safety, the environment, etc., that are specific to the regulatory needs deemed most important to that particular jurisdiction. However, the recent surge in civil society drone use indicates that substantial corresponding legislation changes should be expected.

4 - Case Studies

4.1 - Research: Drones Facilitate New Methodologies

Looking at the effects of climate change and growing food shortages in the ocean, Jan-Olaf Meynecke worried that the health of humpback whales might be suffering in ways unseen from shore. He turned to UAVs for help.[xlvii] The humpback whale population has increased dramatically from their formerly threatened status in recent decades, however, growth in their population size has forced the species to compete for dwindling resources. Meynecke hovers a drone over a whale, and when the whale exhales through its blowhole – twice every three to four minutes – the drone captures a sample of mucus within the exhaled air. Meynecke then brings back the samples for DNA analysis in his marine biology lab at Griffith University in Australia.

Before drones, this type of research would not have been possible, because the act of sampling DNA required the use of boats and crew, which disturbs the whales' behavior. Additionally, boats and crews are expensive and intrusive. Alternative aerial sampling methods, such as the use of large remote helicopters, is not only expensive but also more dangerous. However, using a DJI Phantom UAV that costs roughly 1000 AUD (about 700 USD), Meynecke is able to capture information once largely out of reach.

"The fact that drones have become more affordable and easier to control, with more air time, provides a completely new dimension for research," Meynecke contends. "We might soon be able to even collect skin samples and attach sensors to them."[xlviii]

While UAVs have been available since the 1970s, they have traditionally not been cost-effective tools for most scientific research projects. Today, UAVs are cheaper and more advanced than ever before, leading to a proliferation of scientific use alongside increases in other civil society sectors. Given the decades-long scientific use of UAVs, and the reality that not all research studies make it into newspapers, the total number of scientific uses and their proportion to total drone usage is likely to be significantly higher than reported in this study.

Scientists in fields as varied as archaeology and meteorology have adopted UAVs as a tool for collecting data and exploring the universe through new perspectives. The incorporation of drone use into scientific research projects has enable scientists to conduct research activities that would have formerly been unsafe for humans to conduct themselves. For example, a filmmaker and a California Institute of Technology astrobiologist teamed up to explore the lava lake at Marum crater, Vanuatu with a drone. Their goal was to create a 3D map of the lake and sample its soil for life.[xlix] In another example, archaeologists at the University of Arkansas and University of North Florida used UAVs to collect thermal imagery of archaeological sites to reveal previously unidentified structures, obscured for centuries by erosion and foliage.[l] NASA is working on a drone project that would allow researchers to explore the surfaces of near and distant extraterrestrial bodies independent of interplanetary crafts or rovers.[li] "[Drones] are on their way to becoming

this indispensable and revolutionary technology," said ecologist Adam Watts in an interview with *Nature*.[lii]

Scientists run into many of the same legal hurdles as other drone users, with local legislation often limiting where they may conduct certain types of research. However, because many of these projects are funded at least in part by the federal government, such as with NASA or the National Oceanic and Atmospheric Administration (NOAA).

Technical concerns may also limit what types of scientific research are possible. Although drone technology is becoming more efficient, powerful, and affordable, research designs are still limited by what drones are able to do at this point in time. For example, drones are still too intrusive for Meynecke to collect humpback whale skin samples.[liv] These factors also interact with legislation, as laws and policies--e.g., no fly zones--could prevent ecological research within a certain radius of airports.[lv] Working with lawmakers and engineers would minimize the effect of these technical concerns on scientific research.

4.2 - Wildlife Protection: The UAV and the Oxpecker

Buzzing high above the moonlit landscape, a six-rotor UAV hovers near a roadway on the edge of Kruger National Park in South Africa. With sophisticated imaging hardware, it captures the heat signature of an endangered black rhino and beams coordinates back to a command post. An infrared night-vision scan of the surrounding area reveals a vehicle, out of which jump three men who begin scaling the perimeter fence of the park: poachers. Waiting from the word from the command post, park rangers are deployed near the location of the rhino, ready to intercept the threat. The word is given and the rangers move in, arresting the poachers, and preventing another rhino from being killed for its horn.[lvi]

UAVs are increasingly playing a role in conservation efforts. More and more projects are evolving with objectives of animal observation, monitoring, and protection. Projects like the one in Kruger National Park in South Africa are becoming more common as UAV technology becomes more available. Protecting endangered species with the use of UAVs has created some innovative ventures, from the sophisticated tracking team in South Africa, to a hacked UAV that releases pepper spray to deter elephants from entering an area where they may be in danger.[lvii] Killer whale pods are being monitored by a UAV in order to observe the health of pod members and whether new offspring are present.[lviii] UAVs are also being used by Sea Shepherd to combat Japanese whaling missions,[lix] and illegal seal hunting.[lx]

Recent work by the University of Minnesota focused on how an animal reacts to the presence of a UAV. Researchers used heart-monitoring devices on bears, with the intent to observe the change in heart rate when a UAV is present. Additionally, they used a GPS tracker to see if behavior would be altered with the presence of a UAV. The researchers noticed a significant change in the heart rate of the bears in all of the 18 flights that took place, but they did not notice any behavior change. The researchers hope the findings from their research will create a new

dialogue surrounding "developing regulations and best scientific practices"[lxii] with the UAV as a new research tool in the battle against poaching. Clearly, there is much more to learn as UAVs join other methodological tools in the research and advocacy toolkit.

Larger organizations are getting involved as well. The World Wildlife Fund was recently awarded a $5 million dollar grant from Google for innovative UAV-based approaches to conservation issues, particularly poaching. Their UAV, able to fly for an hour and cover a distance of 18 miles at an altitude 650 feet, can expand the battle against poaching in Africa and Asia by providing information regarding animal locations, danger zones, and ranger deployment.[lxiii] Incentives to create high tech solutions to challenges such as poaching allows conservation groups to level the playing field, particularly as prices by weight for elephant ivory and rhino horn far exceed that of gold, driving poachers to become more technologically cunning. Working together, these efforts have had a significant impact on the abilities of poachers to function, while also leading to an increase in arrests of potential poachers. In some cases, the areas where UAVs are being used have completely eliminated poaching attempts.[lxiv]

Thomas Snitch and his team from the University of Maryland's Institute for Advanced Computer Studies have developed an understanding of the patterns of poaching that take place in Kruger National Park in South Africa.[lxv] The team's data analysis provides a model that directs rangers to the site where a potential target animal will be at a given time, using satellite data. The UAV provides aerial observation and alerts the rangers to when an attempt to kill the animal will take place. Using this complex network of data, technology, and human intervention, Snitch and the team have been able to stop poaching entirely within five to seven days in the area of UAV operation.[lxvi]

Although these technologies are stemming poaching, legislative challenges threaten this use. Kenya, a major poaching hotspot, has recently instituted a broad ban on UAV use, effectively halting such anti-poaching projects.[lxvii] These regulatory measures are far-reaching and may even affect these well-intentioned projects aimed at achieving what seems to be a positive outcome. With such a lucrative black market, however, the disruption of these criminal networks can have a consequential influence on corrupt politicians and policymakers, particularly in less developed countries where economic opportunity often comes from elected positions. While drones cannot solve social, political, and economic problems, they may serve as technical tools for problem solvers. UAVs provide new vantage points for understanding and protecting animals. Observation techniques are less invasive without human presence. Anti-poaching operations have a new element of surprise. Expanding technological capacity is greatly enhancing the scientific and ecological understanding of animals. As UAV technology becomes increasingly available, so will innovative ways to approach animal welfare.

4.3 - Humanitarian Aid: Can For-Profit Drones Change the Face of Humanitarian Aid?

Disasters have both a human and a logistical dimension. The devastation caused by recent natural disasters—the April 2015 Nepal earthquake, the October 2015 French Riviera flood, the November 2015 flash floods in Egypt and Saudi Arabia, and the November 2013 Philippines typhoon—demonstrate the need for and importance of humanitarian aid.[lxviii] Such complex emergencies challenge relief groups to survey damage, identify survivors, and deliver services--three activities drones are getting quite adept at performing.[lxix] While the evolution in humanitarian aid is a direct result of the efforts from non-governmental organizations (NGOs) and collective groups such as the Humanitarian UAV Network, the most influential groups in this humanitarian 'paradigm shift' are corporations, with the California-based Matternet at the frontline of drone-based humanitarian activity.

In January 2013, Matternet announced that it was testing drones as a means of delivering medicine and supplies to remote areas in Lesotho, Haiti, and the Dominican Republic. In addition to delivering medical supplies to camps housing displaced survivors of the 2010 Haiti earthquake, Matternet focused on drone-based deliveries from aid organization to remote areas. Matternet established a number of drone stations to help humanitarian aid groups provide the necessary supplies to individuals largely isolated from relief aid and health care due to the lack of reliable transportation systems and health services in remote parts of the country. With stations situated six miles apart and each drone taking 15 minutes to travel between stations, Matternet says their operations were able to not only able to reach these remote areas faster, but in a more cost-effective manner than traditional aid delivery services. Drawing on its test experience Lesotho, Matternet estimated that it would only cost $900,000 to operate 50 base stations and 150 drones—24 cents per flight—throughout the capital city of Maseru versus the estimated $1 million it would cost to build a 2 kilometer (1.24 miles), one-lane road.[lxx]

Matternet has begun testing a similar approach in Bhutan in 2014, a country that has only 0.3 physicians per 1,000 people.[lxxi] The company's pilot project involved using four drones to connect the Jigme Dorji Wangchuck national Referral Hospital in the capital city of Thimphu to three small healthcare units in more remote areas. Though the country's thin air and humid weather has proved an obstacle to drone-usage, Matternet reports that its drones have functioned without problems (though no drones have been tested in heavy rains).[lxxii] While the company has stated that the drones' "autonomous navigation and battery exchange" still need to be improved and tested before actual humanitarian use was possible,[lxxiii] the implementation of drones as tools for humanitarian aid is an important step towards ensuring that people are better protected and supported during natural disasters.

Though Matternet's projects may ultimately have tremendous impacts on the evolution of humanitarian aid, there are several obstacles that are impeding the company's pursuit of faster, more efficient aid strategies. Specifically, the obstacles come in regulatory form from Bhutan's Department of Civil Aviation (DCA) and the Royal Bhutan Army (RBA), which in April 2015,

announced that drone-use was banned in Bhutan until regulations were established.[lxxiv] Though categorized as a temporary governmental ban, restrictions hamper humanitarian drone research. Researchers from the Ugyen Wangchuck Institute for Environment and Conservation (UWICE) argue the ban prevents them from continuing their drone-based environmental studies, land mapping, disaster prevention, and anti-poaching research.[lxxv] Matternet's desire to establish a drone network within Bhutan took another hit when the country's Director of Public Health Services announced that Matternet could not continue their project due to a lack of government funding.[lxxvi]

As governmental regulations remain a major roadblock for drone use and research, companies such as Matternet are forced to continue their research elsewhere. The absence of drone restrictions and positive reaction to the drone projects in Haiti and the Dominican Republic allow the company to continue improving humanitarian drone use. Matternet has not announced whether their research in Haiti and the Dominican Republic will continue, but the overall outlook for a breakthrough in humanitarian drones-usage remains positive, as countries continue to recognize the potential for drones in critical situations.

4.4 - Civil Society: Crowds, Surveillance, and the Growing Presence of Drones

Civil society groups, non-profit organizations, and individuals have often joined together in the form of rallies, riots, and protests in the hopes of attracting attention to their cause. Yet, the ways that social movements have been able to document their success and failures. Drones have recently been used at rallies, riots, and protests in order to document the unfolding efforts of specific organizations or groups of people.

Camera-equipped drones are a powerful tool for documenting real time footage of social movements and advocacy. This technological shift in documentation allows advocacy groups, journalists, and bystanders to take pictures or videos quickly, efficiently, and, in some cases, anonymously. Drones may be especially useful in estimating crowd sizes. Traditionally, crowds have been measured using a simple formula: "an estimated density of people multiplied by the area they are standing in will give a rough head count."[lxxvii] By calculating crowd sizes in real-time, drones have the potential to better serve civil society actors who aim to convey the volume of their advocacy supporters.[lxxviii]

As drone technology aids civil society groups in crowd estimations, law enforcement and government officials are using drones for monitoring these events. Drones have been adopted by law enforcement in varying degrees, depending on local and national laws within a given country. In most countries, law enforcement is not permitted to use weaponized drones for policing efforts. However, in India, local police have equipped drones with pepper spray in order to control crowds.[lxxix] There have been mixed reactions to police using drones for surveillance purposes—especially those that are weaponized. Drones may aid in crowd monitoring for safety purposes, however the likelihood that this use could be safeguarded from abuse and misperception is

slim.[lxxx] Although there are limited resources concerning drone use and social movement advocacy or surveillance, iRevolutions, the Center for the Study of the Drone at Bard College, and Motherboard all report regularly on such uses.

4.5 - Health and Public Safety: Do Drones Hurt or Help?

Despite the success of disaster-relief drones, however, a number of obstacles have severely restricted the possibility of further utilizing drones for search and rescue operations, with the greatest being the Nepalese government. On May 2015, the Nepalese government restricted drone use to disaster-related use, out of an expressed concern that "sensitive information might be leaked and pictures of its valuable heritage sites [taken] illegally" and the belief that images of historic artifacts were at risk of being misused if photographed.[lxxxi] Nepali Police spokesman Sarvendra Khanal explained that in the aftermath of the earthquake, the Nepalese security agency intercepted a drone they reported was taking illegal photographs of Nepal's heritage sites, presumably under the guise of searching for survivors.[lxxxii] The Nepalese government has continued to enforce these restrictions.

With increased government restrictions worldwide, many humanitarian organizations and groups that rely on drones to conduct search and rescue operations have found their range of motion considerably restricted. Though drones have allowed for the massive expansion of humanitarian aid efforts in the aftermath of the Nepalese earthquake, the government's hesitance on the matter reflects the controversial nature of drones in many spaces. While civil society has shown the prosocial value of drones, the ambiguity associated with UAVs makes the devices difficult to understand and regulate. In response to the growing pushback of many humanitarian groups, the Nepalese government announced that it would allow limited drone use within the country. However, any person or group wanting to use a drone must not only gain approval from Nepal's Civil Aviation Authority, but may only use their drones for research purposes (the government did not specify what it meant by 'research'). Furthermore, drones are still banned from flights in or around UNESCO World Heritage sites and "prohibited areas," though the government did not specify what these prohibited areas encompassed.[lxxxiii] With finite resources and personnel, drones have emerged as one of the best methods of surveying damage and possibly delivering supplies. This benefit will only be realized if governments support their responsible and ethical use.

4.6 - Sub-State Legislation: Poway, CA

"If I wait on the feds, I'll be an old man by the time anything happens," points out Steve Vaus, the mayor of Poway, CA, a town that recently passed a UAV regulatory framework that may prove to be the legislative "tip-of-the-spear" for wildfire-affected areas in Southern California.[lxxxiv] In speaking about his decision to pursue the recently passed ordinance,[lxxxv] Vaus' has addressed drone users as well: "The safety of our first responders takes precedence to your hobby."

Poway's legislation,[lxxxvi] which bans the civilian use of drones whenever the city's Director of Safety deems it necessary to do so, responds to a regulatory need that is especially apparent on the West coast; civilian-controlled drones have frequently interrupted emergency response operations in recent years, including over a dozen times in California's 2015 fire season alone.[lxxxvii] Of course, the strength of drone regulations that rely on activating "no fly zones" in pre-ordained portions of land – a sensible, safety-oriented approach in the advent of a wildfire, for instance – will only be realized if surrounding communities cooperate. Notably, other municipalities in Southern California are watching closely. This potential regional cooperation reflects an observation discussed in the sub-state legislation section above, which notes that the U.S. has seen several small and intermittent waves of sub-state legislation debated (and, to a lesser-degree, passed) as cities recognize and reflect one another's ideas and agendas.

Certainly, there is risk involved in legislative gun-slinging. Haphazardly restrictive regulatory frameworks may diminish the potential for sub-state legislative processes to be sustainable in the advent of increasingly comprehensive state and federal law. Poway's legislation, for instance, allows a city employee to ban drones from certain areas for a wide range of reasons, including "civil unrest."

Municipalities may follow Poway's lead by establishing regulations that serve their community's specific needs. Our hope is that subsequent approaches better balance public safety with individual freedom, especially in areas of police control. Airing on the side of optimism, city officials likely best recognize the needs, desires, and behaviors of their constituents. However, if frameworks such as Poway's are abused by law enforcement agencies – an unfortunate possibility – civilians' ability to use UAVs and other emerging technologies in ways that can benefit their communities will be hampered. While loopholes are inevitable in new types of legislation, laws such as Poway's risk undermining established civil liberties depending on how they are enforced.

5 - Conclusion

To date, drone legislation remains scattered and inconsistent, appearing in fits and spurts as legislative bodies at all levels debate what they are dealing with and how to respond to new technology in the minds of the general public. The near future holds a cascade of state and sub-state legislative adaptation to the new legal environments created by national regulators. The purchase and use of hundreds of thousands of additional drones will raise new issues for debate, most likely centered on whether and how closely national regulators may monitor use and enforce regulations. In the United States, the approach has been to regulate a particular sort of use, namely, the commercial deployment of drones, rather than user- or device-centric regulation. A significant portion of future public debate, however, is likely to focus specifically on the user in addition to the use. This will be especially true if criminal or law enforcement use of drones increases. Publication of this study arguably coincides with the apex of "first wave" of drone legislation, embodied by the FAA's registration requirement and piecemeal patterns at the international, state, and local level. This patchwork approach involves a complicated catch-up process as policymakers in each of these sectors struggle to keep up with private, civil society and for-profit use. As the data in the second section shows, a variety of users are experimenting with a growing number of applications. Legislators are also in a trial and error phase that has sometimes resorted to technical patches, rather than sustainable legislation. One example includes the collaboration between the FAA and Chinese manufacturer DJI to begin incorporating FAA "no fly zone" coordinates into DJI's software upgrades, thereby patching a legislative problem with a short-term technical solution. More sustainable solutions will require greater political will and greater clarity about the nature and pace of future innovation. This study suggests this innovation provides numerous challenges and opportunities for a large and growing host of actors.

In the final analysis, this report draws on a new dataset to introduce a novel typology of both drone use as well as drone users. We also highlight national-level variation in these two factors, ultimately concluding that it is too early to say much other than observe that 1) personal usage has risen significantly, and perhaps permanently; 2) the United States is home to the most reported uses; and 3) legislators are scrambling to define and regulate both users and use. Throughout this report, we have sought to remain agnostic about this technology, recognizing that it can be used for good (art, and law enforcement) and bad (crime and perhaps also law enforcement).

6 - Appendix

6.1 - Data and Methods

This study draws on a combination of qualitative and quantitative methods. The quantitative analysis is drawn from a unique dataset comprised of a representative sample of non-weaponized drone use between 2009 and 2015. The anchor of the qualitative assessment is in-depth case studies of illustrative non-weaponized/unarmed drone use.

The core of the quantitative data comes from a robust sample of drone usage by year using LexisNexis. Each team-member was assigned a year from 2009–2014, and two team-members shared the task of coding for 2015. Searches were limited to newspaper articles and controlled for stories on military drone use, especially in high-conflict regions where the United States was actively involved in targeted killing (e.g., Afghanistan, Iraq, Pakistan, Somalia, Syria and Yemen). Additional terms were controlled for on a year-by-year basis; for example "the drone of the vuvuzela" was a popular audible reference during the 2010 World Cup games in South Africa. Likewise, honey-bee colony collapse was an area that focused on an altogether different drone. The band The Drones experienced a surge of attention in 2010, and The Good Drone Lab wishes them well—they were dropped from the sample frame nevertheless.

If the process yielded more than 1,000 results for the year in question, instances were sorted by date (rather than LexisNexis defined "relevance," which could bias the sample and reduce replicability). In this case, the first 1,000 stories were captured. Two cases were oversampled. Early years, specifically 2009, 2010, and 2011, were oversampled in order to ensure a sufficient range of uses were identified. 2015 was oversampled as well, in order to compensate for the fact that the data only covers nine months rather than twelve (the data was captured in September of 2015). While the underlying sample size for 2015 is a bit larger, the underlying population of stories about drone use increased exponentially, thereby reducing the overall impact of the oversampling. This entire process resulted in the capturing of more than 10,000 articles.

This data was augmented by coding the total population of materials in a number of secondary sources, including: 1) a dataset of usages mapped by New America's Drone Program (n=121 in mid-October, 2014); 2) each weekly report released by Bard's Center for the Study of the Drone from its founding in early 2013 (February 27) through late 2015 (October 12) (3,752 reported instances); 3) all posts on iRevolutions.com (680 blog posts from January 2009 through October 2014), a popular aggregator of humanitarian-related drone stories; and 4) all posts on Motherboard (from month 2011 to October 12, 2015), which has aggressively covered drone issues (670 stories from 2011 mid-October). This process yielded an estimated total of 5,223 codeable items to bring the total sample size to over 15,000.

Each team-member then hand-coded each of these stories according to a criteria of probable purposeful use. In order to avoid coding every single mention of drone use, the team operationalized the notion of purpose. The concept of "purpose" is slippery, as it implies intention. Variation in

purpose is defined through the concept of "purposeful use," which was defined as the apparent or presumed goal-oriented behavior around a primary intended action. Coding for probable purposeful use resulted in 1,366 cases for detailed analysis.

Several caveats are in order: At the most theoretical level, the data presented numerous coding challenges. For example, it was decided (by the first author) that an instance in which the Indian police used a drone to monitor crowd density at a mass religious gathering represented a public safety primary use and a law enforcement secondary use. A nearly identical instance that involved contested political claims and reported police-protester tensions and/or violence was coded as surveillance primary and law enforcement secondary use. Bluntly, "purposeful use" involves difficult judgment calls about the motives behind "presumed goal-oriented behavior." Resource limitations precluded the involvement of multiple reviewers and the establishment of intercoder reliability numbers. The Good Drone Lab anticipates resolving this shortcoming in future versions of this report. The fundamental realities of collaboration and other emerging forms of interaction associated with the use of new, proliferating technologies further complicate the identification of primary intended uses.

Data was cleaned before detailed analysis. In this process, the team removed duplicates and uses that, upon scrutiny, failed the "probable purposeful use" test (i.e., a press release from a corporation announcing a new capacity for a drone). Uses that otherwise did not fit the current definition of drone use, such as autonomous underwater vehicles (AUVs), were additionally removed. This process resulted in a final dataset of 1,145 purposeful uses of drones.

A series of hypotheses and questions were developed that reflected what the team wanted to know about the data, and then descriptive analysis was subsequently conducted on the final dataset to answer these questions. After a brief round of final cleaning, the data and codebook were uploaded into SPSS (Version 23), with clarifying characteristics assigned to each variable (for example: if a variable was "string" or "numeric"). Hypotheses were revised to match what could be represented with the data collected. The team decided on the types of graphs and tables that would be appropriate for which hypotheses and what, conceptually, was the relationship between certain types of variables. Descriptive analytics were run in SPSS in the form of frequencies, cross-tabulation, and graphical output, with the resulting analysis tweaked to fit the needs of the research group (such as altering axes to reflect the 2009-2015 data range).

6.2 - Key Variables

Assessment of the data involved an iterative coding strategy, which blended a first round of closed coding based on a typology originally developed by the first author (Choi-Fitzpatrick 2014) with a subsequent round of open coding. Open coding allowed for a broader range of uses to emerge than anticipated. The following five factors are critical to this study:

Date of Use
Location of User
Location of Use
Type of User
Purpose of Use

Date of Use describes the year in which the drone use took place. When it was not possible to ascertain the date of use, the team logged the report date. While the year, month, and day were coded, the final analysis reports dates by year only.

Location of User describes the country in which the primary user is based. In cases where a collaborative use draws on users from multiple countries, the team attempted to code for the country of the user that appeared to lead the initiative.

Location of Use describes the country in which the primary use took place. In most cases this was the same as the location of the user. In a number of cases, however, the team found international collaborations that resulted in drone use in a second or third country. It is reasonable to expect such efforts will grow as drones are increasingly used for humanitarian relief efforts.

Type of User captures the primary reported user of the device and can be seen in greater detail in section 1.4.

Type of Use describes fifteen types of purposeful uses captured by our open coding schema and can be seen in greater detail in section 1.5.

6.3 - Methodological Considerations: Borders and Sovereignty

A major question arose during the research process: Why were there not more instances of drone use in border regions in the data? Surely individuals and civil society groups would want to use them in order to bypass one of the biggest obstacles of transit in the modern world: national borders. While answers to this question do not currently exist, speculation regarding a few ideas is in order: First, this study only involves documented instances. That is, drone uses that were documented in newspapers, periodicals, blogs, etc. It is likely that most non-government uses are illegal (most undocumented border crossings are) and therefore drone operators are doing their best to not be documented. It is not a stretch to assume that the illegal drug trade may represent a significant percentage of the uses; it would be in drug-traffickers' best interests to avoid having news articles written about them. A second issue may arise out of the fact that only English language sources were included in the final dataset. It is reasonable to assume that there were documented drone uses that were never translated into English. While this does not explain the absence of a large number of border uses, it does provide a possible explanation. A more substantial explanation

may be found by looking at the countries with the most uses. These include the United States, the United Kingdom, Canada, and Australia. It does not take a geography expert to conclude that two of those are islands and therefore wouldn't have many border uses. The United States and Canada do share a border, however no humanitarian crisis is taking place in either country (arguably). The two nations currently hold amicable relations, thus there is little impetus for drone use along their border.

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New America: World of Drones	drones.newamerica.org/
Motherboard	motherboard.vice.com/tag/drones
Bard College: Center for the Study of the Drone	dronecenter.bard.edu/

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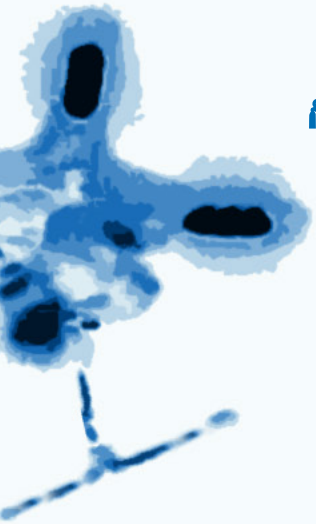

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